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DIVISION 15 - MECHANICAL

SECTION 15610

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12/03

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NASA-15610 (December 2003)
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SECTION 15610

REFRIGERATION COMPRESSORS
12/03

NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers reciprocating, scroll and screw type compressors for refrigerating and air conditioning applications.

Drawings or schedule shall include capacity requirements which should be based on ARI standard rating conditions, capacity control steps, control diagrams, 6-inch 150 millimeter concrete subbase, etc.

ARI 520 covers remote located units.

PART 1 GENERAL

1.1 REFERENCES

NOTE: The following references should not be manually edited except to add new references. References not used in the text will automatically be deleted from this section of the project specification.

The publications listed below form a part of this section to the extent referenced:

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 450	(1999) Water-Cooled Refrigerant Condensers, Remote Type
ARI 460	(1994) Remote Mechanical - Draft Air-Cooled, Refrigerant Condensers

ARI 495	(1993) Refrigerant Liquid Receivers
ARI 520	(1997) Positive Displacement Refrigerant Compressors, Compressor Units and Condensing Units

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI 23	(1993) Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units
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AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
ASHRAE 90A	(1980; 90A-a 1987) Energy Conservation in New Building Design
ASHRAE-05	(1999) Handbook, HVAC Applications (SI Edition)
ASHRAE-06	(1997) Handbook, HVAC Systems and Equipment (IP Edition)
ASHRAE-08	(1998) Handbook, Refrigeration Systems and Applications (SI Edition)
ASHRAE-Hdbk SE-SI	(2000) Handbook, HVAC Systems and Equipment (SI Edition)

ASME INTERNATIONAL (ASME)

ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME BPVC SEC VIII D1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASTM INTERNATIONAL (ASTM)

ASTM A 527/A 527M	(1990) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM A 90/A 90M	(1995; Rev A) Standard Test Method for Weight (Mass) of Coating on Iron or Steel Articles with Zinc or Zinc Alloy

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1 (1986e) Mechanical Vibration - Balance
Quality Requirements of Rigid Rotors -
Part 1: Determination of Permissible
Residual Unbalance

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA MG 1 (1998) Motors and Generators

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1991) Enclosures for Electric Equipment
(1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J636 (1992) V-Belts and Pulleys, Standard

UNDERWRITERS LABORATORIES (UL)

UL 207 (1993; 6th Ed) UL Standard for Safety
Refrigerant - Containing Components and
Accessories, Nonelectrical

UL 303 (1987; 7th Ed; Rev thru April 14, 1995;
Bulletin Jan 9, 1997) UL Standard for
Safety Refrigeration and Air-Conditioning
Condensing and Compressor Units

UL Elec Const Dir (2001) Electrical Construction Equipment
Directory

1.2 GENERAL REQUIREMENTS

NOTE: If Section 15003, "General Mechanical
Provisions," is not included in the project
specification, applicable requirements therefrom
should be inserted and the first paragraph deleted.
If Section 16225, "Motors" is not included in the
project specification, applicable requirements
therefrom should be inserted and the second
paragraph deleted.

Section 15003, "General Mechanical Provisions," applies to work specified
in this section.

Section 16225, "Motors" applies to this section.

Design Analysis and Calculations shall be submitted for reciprocating compressors indicating the manufacturer's recommended power ratings, rotational speeds, and piston speeds.

As-Built Drawings shall be submitted for reciprocating compressor units and shall provide current factual information including deviations from, and amendments to, the drawings and concealed and visible changes in the work.

Results of Contractors survey of Existing Conditions shall include features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

Manufacturer's Standard Color Chart shall indicate the manufacturer's standard color selections and finishes for compressors.

Material, Equipment, and Fixture Lists shall be submitted for reciprocating, scroll and screw type compressor systems including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Equipment Foundation Data shall be submitted including equipment weight and operating loads, location and projection of anchor bolts, and horizontal and vertical clearances for installation, operation, and maintenance. Data shall also include dimensions of foundations and relative elevations, and installation requirements such as noise abatement, vibration isolation, and utility services.

Equipment and Performance Data shall be submitted indicating use life, system functional flows, safety features, and such features as electrical system protective device ratings.

1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01330, "Submittals," and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control. Include a columnar list of appropriate products and tests beneath each submittal description.

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for

reciprocating, scroll and screw type compressor systems in accordance with paragraph entitled, "General Requirements," of this section.

Existing Conditions shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Connection diagrams shall be submitted indicating the relations and connections of the following items. Drawings shall indicate the general physical layout of all controls, and internal tubing and wiring details.

Compressors
Motors
Control Panel
Condensers
Refrigerant-Containing Components
Refrigerant Liquid Receiver

Installation drawings shall be submitted for reciprocating, scroll and screw type compressor units in accordance with paragraph entitled, "Installation," of this section. Drawings shall indicate physical features, dimensions, ratings, service requirements and weights of equipment. Drawings shall also show details of equipment room layout and arrangement.

As-Built Drawings shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-03 Product Data

Equipment Foundation Data and Equipment and Performance Data shall be submitted for the following items in accordance with paragraph entitled, "General Requirements," of this section.

Reciprocating, Scroll and Screw Type Refrigerant Compressor Unit
Reciprocating, Scroll and Screw Type Compressor-Condenser Unit

Manufacturer's catalog data shall be submitted for the following items:

Compressor
Motors
Control Panel
Condensers
Refrigerant-Containing Components
Refrigerant Liquid Receiver
Casing
Vibration Isolation
Accessories

SD-04 Samples

Manufacturer's Standard Color Chart shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-05 Design Data

Design Analysis and Calculations shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-07 Certificates

Listing of Product Installation shall be submitted in accordance with paragraph entitled, "Installation," of this section.

Certificates shall be submitted for following items showing conformance with the referenced standards contained in this section.

- Compressor
- Motors
- Control Panel
- Condensers
- Refrigerant-Containing Components
- Refrigerant Liquid Receiver
- Casing
- Vibration Isolation
- Accessories

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance Data," of this section.

PART 2 PRODUCTS

NOTE: Pump and Motor balance shall conform to ISO 1940-1 - (1986) Balance Quality Requirements of Rigid Rotors - Determination of Permissible Residual Unbalance unless otherwise noted. Motor vibration levels shall conform to NEMA Specification MG-1, Motors and Generators, Part 7 unless otherwise noted.

2.1 RECIPROCATING REFRIGERANT COMPRESSOR UNIT

2.1.1 General

Reciprocating, scroll and screw type refrigerant compressor unit shall consist of a multicylinder compressor, prime mover, drive, and specified accessories for remote location. Unit shall be mounted on a vibration-isolated, welded, rolled structural steel or cast iron base.

2.1.2 Compressor

**NOTE: Call out refrigerant type on drawings or
revise paragraph.**

Compressor shall be [open] [accessible hermetically sealed] type, of
[vertical] [V] [radial] design, suitable for use with one of the
halogenated hydrocarbon refrigerants.

[Refrigerant shall maintain an Ozone Depletion Potential (ODP) of [0.05]
[_____] or less.]

Open- and hermetic-type compressor units shall conform to ARI 520, UL 207.

Compressor shall have integrally cast housing of close-grained iron with
oil-level bull's-eye, cast cylinder heads, cast-aluminum forged-steel
connecting rods, and cast-iron or forged-steel crankshaft. Main bearings
shall be sleeve-insert type. Lubrication system shall be of the
forced-feed, positive-displacement type with oil strainer. Oil pump shall
be reversible. Suction and discharge valves shall be flange connected,
wrench operated, rising stem, with cap. Rotating parts shall be statically
and dynamically balanced at the factory to ISO 1940-1 -1986,
[G6.3][G2.5][G1.0][] to eliminate vibration. Piston speed shall not
exceed the manufacturer's recommendation or 875 feet per minute (fpm) 4.5
meter per second whichever is the lesser. Rotative speed shall not exceed
1,750 revolutions per minute (rpm).

[Shaft seal in open type units shall be oil-sealed mechanical type.]

[Cylinders of compressors larger than 40 tons 150 kilowatt shall be fitted
with removable, interchangeable liners.]

[Tandem compressors, i.e., units using one double-ended motor to drive two
compressor assemblies, are not acceptable.]

Compressor unit shall be [air-cooled type] [water-cooled type].

V-belt drive shall conform to ASHRAE-06 ASHRAE-Hdbk SE-SI, Chapter 41; and
SAE J636, and shall be rated at not less than 1.5 times the identification
plate motor power rating.

**NOTE: Select the following paragraph for units
sized 10 horsepower with a power of 8 kilowatt and
smaller.**

Compressor capacity control for units of 10 horsepower with a power of 8
kilowatt and smaller shall be on/off type.

NOTE: Select or delete the following paragraph for two-speed motors 10 horsepower with a power of 8 kilowatt and smaller.

Two-speed, two-winding motors shall provide capacity reduction for units of 10 horsepower with a power of 8 kilowatt or smaller, if the manufacturer catalogs the compressor body at both speeds and certifies that there will be no operating difficulties.

NOTE: Select or delete the following paragraph for duplex units sized 7-1/2 horsepower with a power of 6 kilowatt and smaller.

Capacity control for duplex compressor units sized 7-1/2 horsepower with a power of 6 kilowatt and smaller shall be on/off type, providing a minimum of 50-percent capacity reduction.

NOTE: Select the following paragraph for units larger than 10 horsepower with a power of 8 kilowatt or rewrite to provide partial bypass ports or suction pressure regulators.

Compressor capacity control for units larger than 10 horsepower with a power of 8 kilowatt shall be automatic, in indicated number of steps, with externally adjustable set points, and shall be accomplished by a hydraulic suction valve lifting mechanism actuated by suction pressure. Control system components and piping shall be completely internal. Compressor shall not vibrate under any normal load conditions.

2.1.3 Motors

Hermetically sealed motors shall conform to requirements NEMA MG 1 and ARI 520 for motors specified herein, except that two manually resettable thermal overload protective devices shall be located within motor windings.

2.1.4 Control Panel

NOTE: Rewrite for remote location as necessary.

Compressor-mounted control panel and intercomponent piping and wiring shall be provided. Piping connections to panel shall be made with components conforming to ASME B16.26, shall be isolable, and shall be made with service-rated flexible connectors to isolate vibration. Electrical work shall conform to requirements of NFPA 70 and shall be constructed of UL Elec Const Dir listed components.

NOTE: Coordinate following paragraph with "electrical work" specifications herein and control drawings; rewrite, supplement, or delete as necessary to suit project conditions.

Some manufacturers feel that discharge and pressure gages, alarms, and disconnect switches should be field installed.

Control panel shall be complete with all safety and operating controls and shall have the intercomponent wiring to terminals necessary for field connection and automatic operation. Controls shall include:

Disconnect switch

Overload protective devices

Transformers

Motor controllers

Interlocks

Relays

Suction and discharge pressure gages

Audible and visual alarm

Pushbuttons, pilot lights, and other control devices

Enclosure shall conform to NEMA 250, as follows:

NOTE: Select for indoor use to protect against contact with enclosed equipment.

Type 1 - General purpose

NOTE: Select for outdoor locations to protect against rain, sleet, and ice.

Type 3R - Weather-resistant (raintight)

NOTE: Select for indoor or outdoor use to protect against windblown dust and rain.

Type 4 - Watertight and dusttight

NOTE: Select for indoor use to exclude dust, lint,
fibers, oil seepage, coolant seepage.

Type 12 - Indoor use, dusttight and driptight

NOTE: Select one of the following two paragraphs
only for limited units conforming to ARI 520.

[Motor controllers shall be magnetic type.]

[Motor controllers shall be magnetic contactor type.]

NOTE: Select for units conforming to ARI 520.

[Motor controllers shall be combination type.]

2.1.5 Accessories

Unit accessories shall include all items listed in referenced applicable standard.

Crankcase-oil heaters shall be provided and shall be controlled as recommended by the manufacturer.

[An external oil filter (in addition to oil pump suction strainer) and magnetic plugs in crankcase shall be provided.]

2.1.6 Vibration Isolation

NOTE: Ensure that Section 15072, "Vibration
Isolation for Air Conditioning Equipment," is
included in the project specification.

Vibration isolation provisions shall conform to requirements specified under Section 15072, "Vibration Isolation for Air Conditioning Equipment."

2.2 RECIPROCATING COMPRESSOR-CONDENSER UNIT

2.2.1 General

Reciprocating, scroll and screw type compressor-condenser unit shall include a multicylinder compressor, prime mover, drive, condenser, receiver, intercomponent piping and wiring, control panel, and specified accessories for remote location. Unit shall be mounted on a vibration-isolated, welded structural steel base ready for terminal field

connections. Energy efficiency rating shall meet or exceed ASHRAE 90A requirements.

2.2.2 Compressors

NOTE: Rewrite the following paragraph if specific
type is required. Call out refrigerant type on
drawings or revise the paragraph.

Compressor shall be open or accessible hermetically sealed, [vertical] [V]
[radial] design, suitable for use with one of the halogenated hydrocarbon
refrigerants.

Open type and hermetic compressor units shall conform to ARI 520, UL 207.

Compressor shall have integrally cast housing of close-grained iron with
oil-level bull's-eye, cast cylinder heads, cast-aluminum or forged-steel
connecting rods, and cast-iron or forged-steel crankshaft. Main bearings
shall be sleeve-insert type; lubrication system shall be of the forced-feed
positive-displacement type with oil strainer. Oil pump shall be
reversible. Suction and discharge valves shall be flange connected.
Rotating parts shall be statically and dynamically balanced at the factory
to eliminate vibration. Piston speed shall not exceed the manufacturer's
recommendation, or 875 fpm 4.5 meter per second, whichever is the lesser.
Rotative speed shall not exceed 1,750 rpm.

[Shaft seal in open type units shall be oil-sealed mechanical type.]

[Cylinders of compressors larger than 40 tons 150 kilowatt shall be fitted
with removable, interchangeable liners.]

[Tandem compressors, i.e., units using one double-ended motor to drive two
compressor assemblies, are not acceptable.]

V-belt drive shall conform to ASHRAE-06 ASHRAE-Hdbk SE-SI, Chapter 41; and
SAE J636, and shall be rated at not less than 1.5 times the identification
plate motor power rating.

NOTE: Select the following paragraph generally for
units sized 10 horsepower with a power of 8 kilowatt
and smaller.

Compressor capacity control for units of 10 horsepower with a power of 8
kilowatt and smaller shall be on/off type.

NOTE: Select or delete the following paragraph for
two-speed motors 10 horsepower with a power of 8
kilowatt and smaller.

Two-speed, two-winding motors shall provide capacity reduction for units of 10 horsepower with a power of 8 kilowatt or smaller, if the manufacturer catalogs the compressor body at both speeds and certifies that there will be no operating difficulties.

NOTE: Select or delete the following paragraph for duplex units sized 7-1/2 horsepower with a power of 6 kilowatt and smaller.

Capacity control for duplex compressor units sized 7-1/2 horsepower with a power of 6 kilowatt and smaller shall be on/off type, providing a minimum of 50-percent capacity reduction.

NOTE: Select the following paragraph for units larger than 10 horsepower with a power of 8 kilowatt or rewrite to provide partial bypass ports or suction pressure regulators.

Compressor capacity control for units larger than 10 horsepower with a power of 8 kilowatt shall be automatic, in indicated number of steps, have externally adjustable set points, and shall be accomplished by a hydraulic suction valve lifting mechanism actuated by suction pressure. Control system components and piping shall be completely internal. Compressor shall not vibrate under any normal load condition.

2.2.3 Accessories

Unit accessories shall include all items listed in referenced applicable standards and specified herein.

Crankcase-oil heaters shall be provided and shall be controlled as recommended by the manufacturer.

[An external oil filter (in addition to oil pump suction strainer) and magnetic plugs in crankcase shall be provided.]

2.2.4 Air-Cooled Condensers

Condenser shall conform to the applicable requirements of UL 303, UL 207, ASHRAE 15, ANSI 23, and ARI 460.

NOTE: Add time delay relay to prevent restart of compressor without a time duration for refrigerant flow to stabilize, if so desired.

[Units shall be suitable for startup and operation in ambient temperatures down to 0 degrees F minus 18 degrees C.]

2.2.4.1 Fans and Drives

**NOTE: Use for on-the-roof and other applications
where noise is not a factor.**

[Fans shall be propeller type, of corrosion-resistant construction, and shall be statically and dynamically balanced. Fan discharge shall be vertical. Maximum fan tip speed shall be 10,000 fpm 50 meter per second.]

**NOTE: Use for on-grade locations adjacent to
offices, in situations requiring ducting, and
generally for low noise levels.**

**Where noise is a factor, drawings should show
limiting speeds, outlet velocities or noise criteria
to suit project conditions.**

[Fans shall be double-width, double-inlet, centrifugal-scroll type with forward curved or airfoil-section blade wheels. Fans shall be of corrosion-resistant construction and shall be statically and dynamically balanced. Fan shaft first critical speed shall be 20 percent above fan operating speed.]

**NOTE: Select the following only for propeller fan
units smaller than 2 horsepower 1500 watt.**

Fan drive shall be direct.

**NOTE: Select or rewrite the following for propeller
or centrifugal fans. For critical operations,
specify not less than two belts.**

Fan drive shall be V-belt, with corrosion-protected shaft and antifriction type bearings. Drive shall conform to ASHRAE-06 ASHRAE-Hdbk SE-SI, Chapter 41; and SAE J636, and shall be rated at not less than 1.5 times the identification plate motor power rating. Bearings shall be sealed against moisture and dirt, shall be [prelubricated, and suitable for not less than 10,000 operating hours without need of relubrication] [lubricable type with grease supply and relief fittings together with extension tubing for accessibility]. Bearing cavity shall be completely packed with a grease suitable for the service. Grease shall be identified by military specification number on the shop drawings.

[Fan drive shall be equipped with an adjustable sheave sized for installation at its midpoint setting and shall provide 20 percent speed

adjustment.]

Drive shall be weather protected. Fan guards shall be hot-dip galvanized after fabrication and shall be suitable for salt air atmosphere; electrogalvanizing is not acceptable.

2.2.4.2 Condensing Coil

NOTE: Check subcooling requirements for project.

Condensing coils shall be designed and sized specifically for air-cooled condenser service. Coil construction shall be seamless copper tube, with copper extended surface integral with or mechanically attached to the tube. Coil frame shall be not less than 12-gage 2.8 millimeter galvanized steel. A purging vent shall be provided at the highest point of the entering refrigerant header of each coil circuit. Coil shall be provided with a subcooling circuit; not less than 15 degrees F minus 9 degrees C subcooling shall be provided when a differential not greater than 20 degrees F 11 degrees C (absolute) exists between condensing and ambient temperatures.

Where a condenser is being used as a combination receiver, the pump-down capacity shall be 80 percent of the available condenser volume. Coil shall be protected from physical damage.

2.2.4.3 Condensing Pressure Control

NOTE: Retain the following paragraph only for single-phase powered units.

Condensing pressure control shall be accomplished by an electronic solid-state control system that will modulate speed of a motor conforming to requirements specified herein from 0 to 100 percent by fan cycling or by a combination of methods.

NOTE: Retain one of the following two paragraphs for single- or three-phase powered units.

[Condensing pressure control shall be accomplished by [condenser-coil flooding system] [by modulation of dampers located in the discharge airstream].]

[Condensing pressure control shall be accomplished by fan cycling, by modulation of dampers located in the discharge airstream, or by a combination of methods.]

2.2.5 Water-Cooled Condensers

2.2.5.1 General

Water-cooled condenser shall include water and refrigerant connections, purge valve, relief devices, and refrigerant valves.

Condenser shall conform to ASHRAE-06 ASHRAE-Hdbk SE-SI, Chapter 36; ARI 450 and ASME BPVC SEC VIII D1 with stamp.

[Where a condenser is being used as a combination receiver, the pump-down capacity shall be 80 percent of the available condenser volume.]

**NOTE: Select or revise the following as necessary
with consideration for type of water treatment being
used.**

[Unit shall be selected for water velocities not in excess of 7 fps 2 meter per second and a fouling factor of 0.0010.]

2.2.5.2 Construction

[Condensing surface between halogen refrigerant and cooling water shall be copper or brass.]

[Condensing surface between halogen refrigerant and cooling water shall be copper; tube sheets shall be nonferrous metal.]

[Condensers, 10 tons 35 kilowatt and less refrigeration capacity, shall be of the shell-and-coil, shell-and-U-tube, or shell-and-tube type construction.]

[Condensers larger than 10 tons 35 kilowatt refrigeration capacity shall be of the shell-and-tube, cleanable-type construction, and tubes shall be rolled or brazed into tube sheet.]

**NOTE: Select or delete the following paragraph for
units sized 10 tons 35 kilowatt and smaller.**

Coil joints shall be brazed or silver-soldered.

Intermediate tube supports shall be provided so that distance between straight tube supports does not exceed 3 feet 900 millimeter for copper tubes and 4 feet 1200 millimeter for brass tubes. Supports shall be fitted to the tubes in a manner to preclude corrosion, vibration, and abrasion.

2.2.6 Refrigerant-Containing Components

Refrigerant-containing components shall conform to applicable portions of ASHRAE 15, UL 207.

Compressor suction and discharge valves shall be flange connected, wrench operated, rising stem type, and with cap. All other valves shall be packless type, wherever possible.

Refrigerant circuit shall be factory cleaned and factory charged with dry nitrogen or refrigerant.

2.2.7 Refrigerant Liquid Receiver

2.2.7.1 General

Receiver shall conform to ASHRAE-05, ASHRAE-08, ASHRAE-Hdbk SE-SI, ARI 495, ASME BPVC SEC VIII D1 with stamp, and to requirements specified herein.

Pump-down capacity of receiver shall be 80 percent of the internal volume of the receiver.

2.2.7.2 Construction

Receiver shall be equipped with inlet pipe, outlet drop pipe, drain plug, purging valve, relief valves of capacity and setting required by ASHRAE 15, and two bull's-eye liquid-level sight glasses. Sight glasses shall be in the same vertical plane, 90 degrees apart, perpendicular to the axis of the receiver, and not over 3 inches 75 millimeter horizontally from the drop pipe measured along the axis of the receiver. In lieu of the bull's-eye sight glass, external gage glass with metal glass guard and automatic closing stop valves may be provided.

2.2.8 Motors

Hermetically sealed compressor motors shall conform to NEMA MG 1, requirements for motors specified herein and to ARI 520, except that two manually resettable thermal overload protective devices shall be located within motor windings.

NOTE: Select the following paragraph for all air cooled condenser unit.

Condenser fan motors shall be totally enclosed types and shall conform to requirements specified herein.

NOTE: Select the following paragraph for direct drive air cooled units.

Condenser fan motors shall be resiliently mounted.

2.2.9 Control Panel

NOTE: Rewrite for remote location as necessary.

A unit mounted control panel shall be provided. All piping connections to the panel that do not affect safe operation shall be made isolable and shall be made with service rated flexible connectors where necessary to isolate vibration. All electrical work shall conform to NFPA 70 and shall be constructed of UL-listed components. Enclosures shall be NEMA 250, Type 1, except that weather-exposed enclosures shall be NEMA 250, Type 3R.

NOTE: Coordinate the following paragraph with control drawings.

Control panel shall be complete with all safety and operating controls required for fully automatic operation, including discharge and suction pressure gages, audible alarm, pilot lights, selector switches, interlocks, transformers, motor controllers, unfused disconnect switch, and intercomponent wiring ready for field connection.

2.2.10 Casing

[Weather-exposed equipment shall successfully withstand the rain test described in UL Elec Const Dir.]

Casing shall include a corrosion-protected structural steel frame and sheet metal enclosure.

Casing sheet metal shall be minimum 18-gage 1.3 millimeter mill galvanized steel that has been phosphatized, primed, and finished with the manufacturer's standard enamel.

NOTE: Use 2.5 ounces per square foot 763 grams per square meter of zinc for "heavy duty" with 16-gage 1.6 millimeter and heavier steel.

Mill galvanized steel shall conform to ASTM A 527/A 527M, and shall be coated with not less than 1.25 ounces zinc per square foot 381 gram zinc per square meter of two-sided surface when tested in accordance with ASTM A 90/A 90M.

Casing frame shall be constructed of [mill galvanized steel] [shall be hot-dip galvanized after fabrication to equal or exceed mill galvanizing requirements].

Casing shall include access doors and coil end enclosure.

Control panel shall be located [within] [external to] casing.

2.3 Vibration Isolation

NOTE: Ensure that Section 15072, "Vibration Isolation for Air Conditioning Equipment," is included in the project specification.

Vibration isolation provisions shall conform to requirements specified under Section 15072, "Vibration Isolation for Air Conditioning Equipment."

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed in accordance with manufacturer's recommendations. Compressors shall be installed with isolation service valves on inlet and discharge lines.

Listing of Product Installation shall be submitted for reciprocating compressor units showing at least 5 installed units, similar to those proposed, that have been in successful service for a minimum period of 5 years. List shall include purchaser, address of installation, service organization, and date of installation.

3.2 TESTING

3.2.1 Vibration

Contractor shall use an FFT analyzer to measure vibration levels. It shall have the following characteristics: A dynamic range greater than 70 dB; a minimum of 400 line resolution; a frequency response range of 5Hz-10 KHz(300-600000 cpm); the capacity to perform ensemble averaging, the capability to use a Hanning window; auto-ranging frequency amplitude; a minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB.

An accelerometer, either stud-mounted or mounted using a rare earth, low mass magnet and sound disk(or finished surface) shall be used with the FFT analyzer to collect data. The mass of the accelerometer and its mounting shall have minimal influence on the frequency response of the system over the selected measurement range.

Contractor shall take vibration readings at each bearing location in the horizontal, vertical, and axial(if possible) directions and the data shall be provided as part of the final test data.

Coils shall be tested pneumatically under water at not less than 400 psig 2800 kilopascal.

Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion

in the Maintenance Database."

3.3 OPERATION AND MAINTENANCE DATA

Contractor shall submit [6] [_____] copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the reciprocating, scroll and screw type compressor units. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

-- End of Section --